

# Novel Metal-Organic Frameworks for Thermoelectrics

Turning wasted heat into electricity using honeycomb materials



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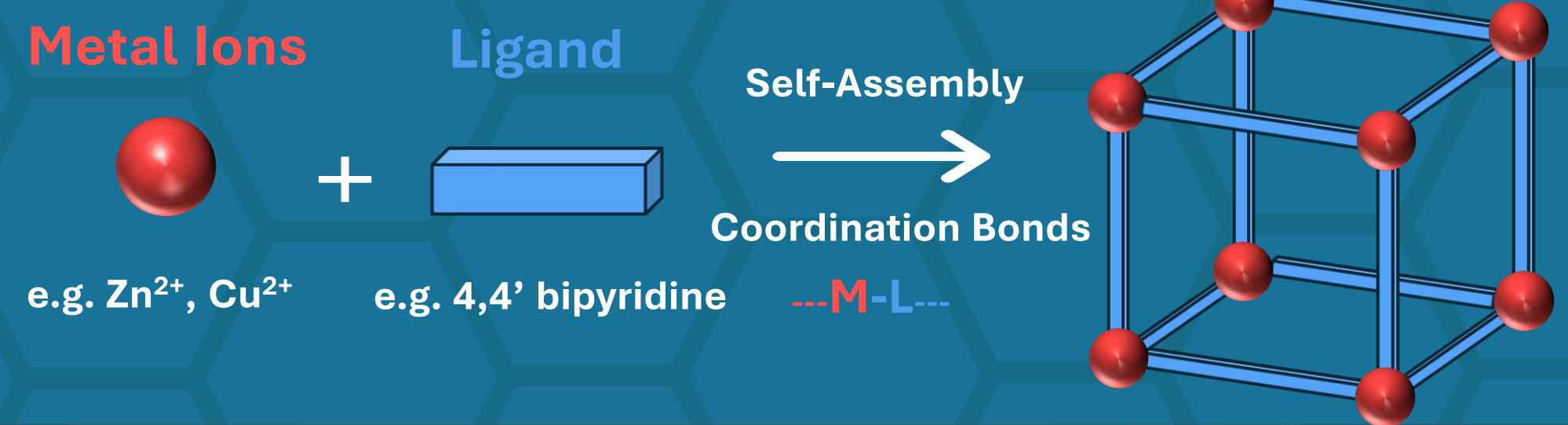
## 1 Thermoelectrics

- ✓ Thermoelectrics (TEs) can generate electricity from heat
- ✓ Useful for wearable electronics and energy regeneration
- ✗ Current materials are expensive and non-tuneable



## 2 Metal-Organic Frameworks

- Metal-Organic Frameworks (MOFs) are sponge-like materials made from molecular building blocks
- They form structures with extremely large surface areas, with 1 gram containing up to the area of a football pitch!
- Changing the building blocks lets us control how electricity flows - their properties are highly tuneable



## 3 Thermoelectric MOFs: Can We Harvest Energy from Honeycombs?

- 2D-Layered MOFs, with a honeycomb-like structure, show promise as next-generation thermoelectric materials
- Can 2D MOFs be tuned by their environment to improve thermoelectric performance?

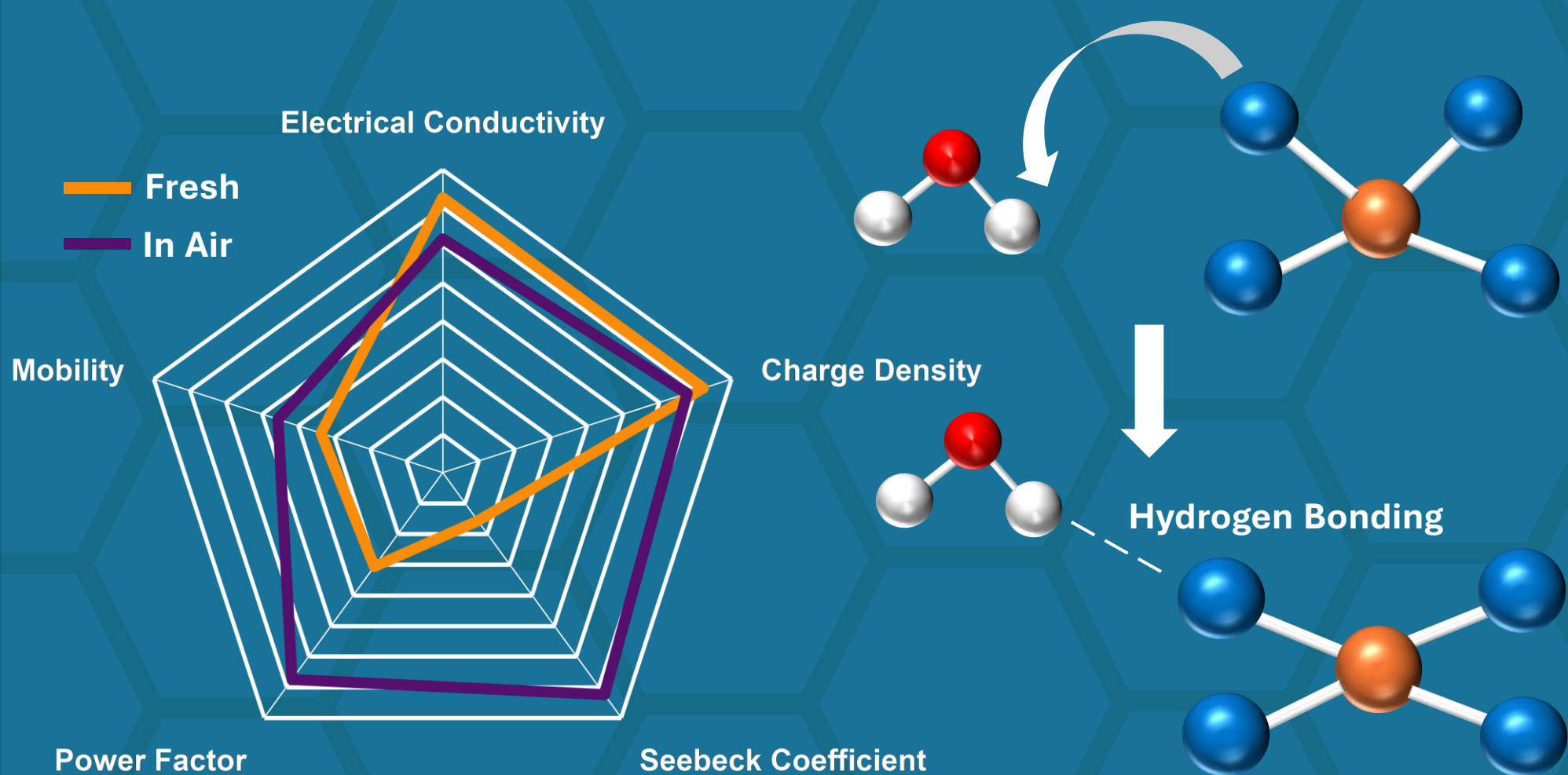
$$zT = \frac{\alpha^2 \sigma}{(k_p + k_e)} T$$

Higher zT = More Electricity from Heat

	TE MOFs	Old TEs
Safety	↑	↓
Abundance	↑	↓
Tuneability	↑	↓
Power Output	↓	↑

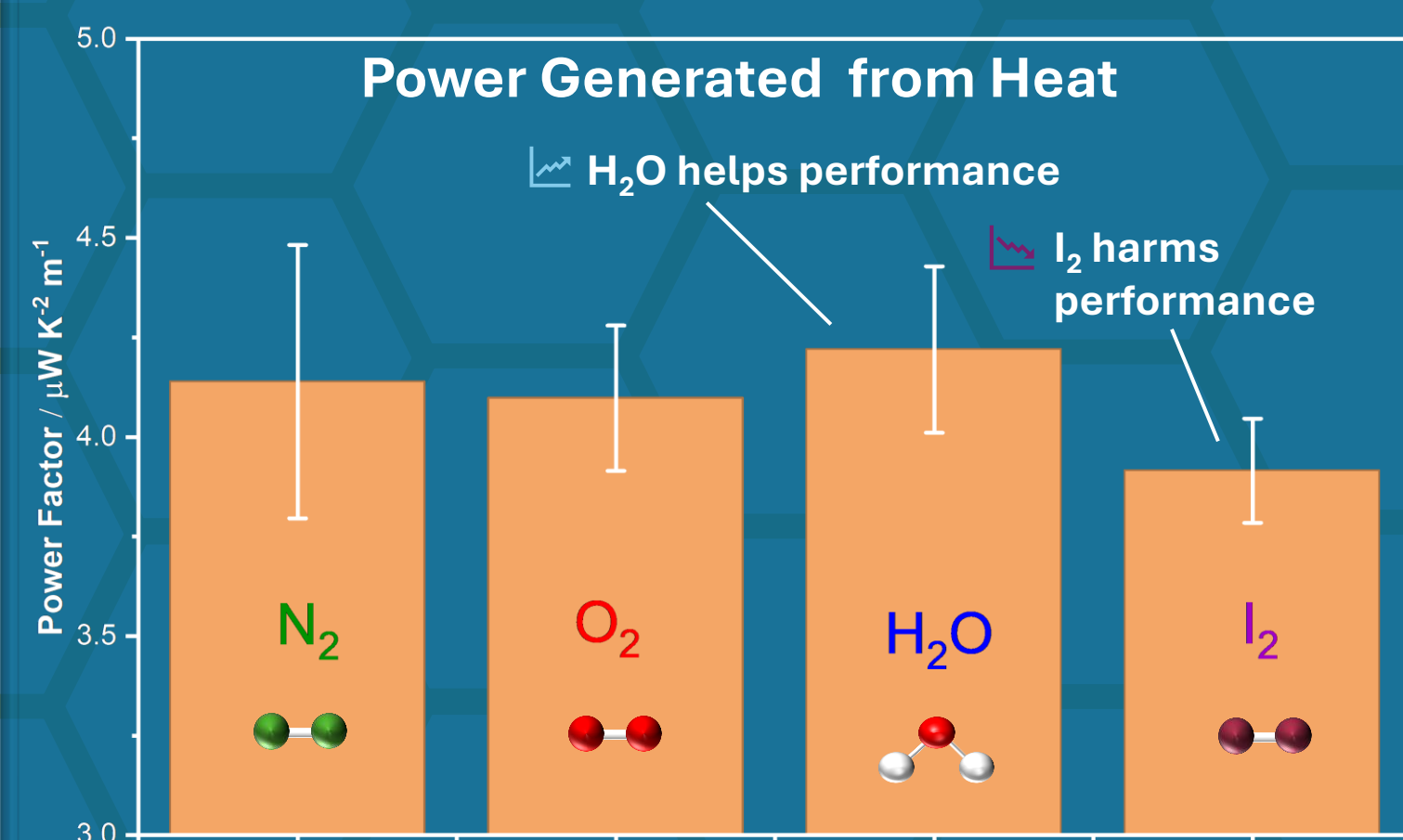
## 4 Powders

- Cu-HITP MOF prepared as powder and pelletised
- Performance improved when exposed to air due to interaction with  $H_2O$  behaving as 'dopant'



## 5 Films

- New method developed to prepare Ni-HITP MOF as a thin film
- We deliberately tuned the performance of films by flowing gases using a specialised cell at a synchrotron: a high-powered X-Ray source
- This helped us see how materials behave in real time



## 6 Summary & What's Next?

We have demonstrated that thermoelectric MOFs are dynamic materials whose performance can be tuned by their environment

Future work:

- 🔧 Improve crystallinity and particle size to maximise power output
- 📖 Explore more materials in the MOF library
- 🌱 Develop new synthetic methods that focus on sustainability and efficiency



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diamond



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